Japanese Patent Application No. 2004-037410 (filed on February 13, 2004)

[Document Name] Patent Application
[Docket Number] P040094
[Filing Date] February 13, 2004
[To] Commissioner, Patent Office
[International Classification] D01F 9/12
[Inventor]
[Address or Domicile] c/o Otake Plants,
Mitsubishi Rayon Co., Ltd.,
20-1, Miyuki-cho, Otake-shi, Hiroshima
[Name] Katsuhiko IKEDA
[Inventor]
[Address or Domicile] c/o Otake Plants,
Mitsubishi Rayon Co., Ltd.,
20-1, Miyuki-cho, Otake-shi, Hiroshima
[Name] Nobuyuki SHIMOZAWA
[Inventor]
[Address or Domicile] c/o Otake Plants,
Mitsubishi Rayon Co., Ltd.,
20-1, Miyuki-cho, Otake-shi, Hiroshima
[Name] Atsushi KAWAMURA
[Inventor]
[Address or Domicile] c/o Otake Plants,
Mitsubishi Rayon Co., Ltd.,
20-1, Miyuki-cho, Otake-shi, Hiroshima
[Name] Takahiko KUNISAWA
[Applicant]
[Identification Number] 000006035
[Name or Appellation] MITSUBISHI RAYON CO., LTD.
[Agent]
[Identification Number] 100123788
[Patent Attorney]
[Name or Appellation] Teruo MIYAZAKI
[Telephone Number] 03-3585-1882

[Agent]
[Identification Number] 100106297
[Patent Attorney]
[Name or Appellation] Katsuhiro ITO
[Agent]
[Identification Number] 100106138
[Patent Attorney]
[Name or Appellation] Masayuki ISHIBASHI
[Indication of Official Fees]
[Advance Deposit Record Number] 201087
[Amount paid] 21,000 yen
[List of Materials Submitted]

[Material Name]	Claims	1
[Material Name]	Specification	1
[Material Name]	Drawings	1
[Material Name]	Abstract	1

CLAIMS

1. A carbon fiber precursor fiber bundle, characterized by:
consisting of substantially straight fibers without imparted crimp; and
having a widthwise dividing capability to maintain a form of a single aggregate of tows when housed in a container, taken out from the container and guided into a firing step, and to divide into small tows in the firing step by the tension generated in the firing step.

2. The carbon fiber precursor fiber bundle according to claim 1, wherein the monofilament fineness is from 0.7 to 1.3 dtex, the number of filaments of the small tow is from 50,000 to 150,000, and the total number of filaments in the aggregate of tows is from 100,000 to 600,000.

3. The carbon fiber precursor fiber bundle according to claims 1 or 2, wherein the form of the aggregate of tows is kept by intermingling filaments between a widthwise end of a small tow and a widthwise end of the adjacent small tow by air flow.

4. The carbon fiber precursor fiber bundle according to claim 3, wherein a degree of intermingle between the small tows based on the hook drop method is 1 m^{-1} or less.

5. The carbon fiber precursor fiber bundle according to any of claims 1 to 4, wherein the number of monofilaments undergoing adhesion between the monofilaments is 5 per 50,000 of monofilaments or less and the size of the crystal region in a direction perpendicular to the fiber axis is 1.1×10^{-8} m or more.

6. The carbon fiber precursor fiber bundle according to any of claims 1 to 5, wherein the strength of a monofilament is 5.0 cN/dtex or more, and the fineness unevenness (CV value) of the monofilament is 10% or less.

7. The carbon fiber precursor fiber bundle according to any of claims 1 to 6, wherein the oiling agent adhesion unevenness (CV value) along the lengthwise direction is 10% or less.

8. The carbon fiber precursor fiber bundle according to any of claims 1 to 7, wherein the degree of swelling of a swollen yarn before drying is 100% by mass or less.

9. A production method of a carbon fiber precursor fiber bundle, characterized by comprising:

washing/drawing swollen yarn, the swollen yarn being formed by extruding an organic solvent solution of an acrylonitrile-based polymer into an aqueous solution of dimethylacetamide from a spinning nozzle having a nozzle hole diameter of from 45 to 75 μm and the number of holes of 50,000 or more at a coagulated yarn take-up speed/extrusion linear speed of 0.8 or less,

thereafter, imparting a first oiling agent to the yarn by guiding the yarn into a first oil bath, and once squeezing the yarn by use of guides, and subsequently imparting a second oiling agent to the yarn in a second oil bath,

drying, densifying and secondarily drawing the yarn to achieve a total drawing magnification of from 5 to 10.

10. The production method of a carbon fiber precursor fiber bundle according

to claim 9, wherein the organic solvent is dimethylacetamide.

11. The production method of a carbon fiber precursor fiber bundle according to claim 9 or 10, wherein

arranging a plurality of small tows so as to be in parallel and adjacent to each other,

feeding the small tows to an intermingling device that comprises a flat rectangular sectional shape of a yarn channel and that is provided with a plurality of air jet holes which are disposed in the yarn channel with a predetermined interval along the long side direction of the flat rectangular section, and

jetting out air from the air jet holes to intermingle the adjacent small tows with each other.

12. The production method of a carbon fiber precursor fiber bundle according to claim 11, wherein water is imparted in advance to the small tows before the intermingling so that their water content is 10 wt % or less.

13. The production method of a carbon fiber precursor fiber bundle according to claims 11 or 12, wherein filaments within the small tow are intermingled with each other by passing the small tow through an intermingling device that comprises a yarn channel having a circular section and an air jet hole for jetting out air to said yarn channel having a circular section, and by jetting out air from said air jet hole.

14. The production method of a carbon fiber precursor fiber bundle according to claims 11 or 12, wherein filaments within the small tow are intermingled with each other by passing the small tow through an intermingling device provided

with a plurality of air jet holes which are disposed with a predetermined interval along the long side direction of the flat rectangle of a yarn channel having a flat rectangular sectional shape, and by jetting out air from said air jet holes.

15. The production method of a carbon fiber precursor fiber bundle according to claims 11 or 12, wherein filaments of the small tow are intermingled and the small tows are intermingled with each other by feeding a plurality of small tows so as to be adjacent to each other into an intermingling device that comprises a plurality of jet holes which are disposed in a yarn channel having a flat rectangular section with a predetermined interval along the long side direction of the flat rectangle, and by jetting out air from said air jet holes.

16. The production method of a carbon fiber precursor fiber bundle according to claim 11 or 12, wherein filaments of the small tow are intermingled and the small tows are intermingled with each other by feeding a plurality of small tows so as to be adjacent to each other into an intermingling device that comprises a plurality of jet holes which are disposed in a yarn channel having a flat rectangular section with a predetermined interval along the long side direction of the flat rectangle and that further comprises a groove which extends along the lengthwise direction of the yarn channel at a position where the small tows are adjacent to each other, and by jetting out air from said air jet holes.

17. The production method of a carbon fiber precursor fiber bundle according to claim 14, wherein a plurality of the small tows in which filaments having been intermingled with each other in advance are intermingled with each other by feeding a plurality of the small tows so as to be adjacent to each other into an intermingling device that comprises a groove which extends along the lengthwise

direction of a yarn channel at a position where the small tows are adjacent to each other in the yarn channel having a flat rectangular section and that also comprises a plurality of air jet holes which are disposed only in the groove with a predetermined interval along the long side direction of the flat rectangle, and by jetting out air from said air jet holes.

18. The production method of a carbon fiber precursor fiber bundle according to any of claims 11 to 17, comprising housing in a container the single aggregate of tows consisting of a plurality of intermingled small tows after the aggregate of tows has been fed to a gear roll.

19. The production method of a carbon fiber precursor fiber bundle according to any of claims 11 to 17, comprising housing in a container the single aggregate of tows consisting of a plurality of intermingled small tows after the aggregate of tows has been fed to a nip roll.

20. A production apparatus of a carbon fiber precursor fiber bundle for producing the carbon fiber precursor fiber bundle according to any of claims 1 to 4, characterized by comprising a yarn channel having a flat rectangular section capable of being fed a plurality of small tows which are adjacent to each other, the yarn channel comprising a plurality of air jet holes which are open with a predetermined interval along the long side direction of the flat rectangular section.

21. A production apparatus of a carbon fiber precursor fiber bundle for producing the carbon fiber precursor fiber bundle according to any of claims 1 to 4, characterized by comprising:

a first intermingling device that comprises one or more air jet holes for

jetting out air into a yarn channel having a circular section capable of passing a small tow and; and

a second intermingling device that comprises a yarn channel having a flat rectangular section capable of being fed a plurality of small tows which are adjacent to each other and that comprises a plurality of air jet holes which are disposed with a predetermined interval along the long side direction of the flat rectangle in this yarn channel.

22. A production apparatus of a carbon fiber precursor fiber bundle for producing the carbon fiber precursor fiber bundle according to any of claims 1 to 8, characterized by comprising:

a first intermingling device that comprises one or more air jet holes for jetting out air into a yarn channel having a flat rectangular section capable of passing a small tow and; and

a second intermingling device that comprises a yarn channel having a flat rectangular section capable of being fed a plurality of small tows which are adjacent to each other and are in parallel and that comprises a plurality of air jet holes which are disposed with a predetermined interval along the long side direction of the flat rectangle in this yarn channel.

23. The production apparatus of a carbon fiber precursor fiber bundle according to any of claims 20 to 22, wherein the yarn channel having a flat rectangular section capable of being fed a plurality of small tows which are adjacent to each other further comprises a plurality of grooves which extends along the lengthwise direction of the yarn channel at a position where the small tows are adjacent to each other.

24. The production apparatus of a carbon fiber precursor fiber bundle according to claim 23, wherein the air jet holes are formed only in the plurality of the grooves.

25. The production apparatus of a carbon fiber precursor fiber bundle according to claim 20, wherein the ratio n·D/L of the total fineness nD (dTex) of an aggregate of tows represented by the product between the total fineness D (dTex) of the small tow and the number n of the filaments to be aggregated to the long side dimension L (mm) of the flat section is from 2,000 to 8,000 dTex/mm, and the diameter of each of the air jet holes is from 0.3 to 1.2 mm.

26. The production apparatus of a carbon fiber precursor fiber bundle according to claim 20, wherein the air jet holes are disposed with an even pitch, and the pitch is from 0.8 to 1.6 mm, and the length of the yarn channel is from 10 to 40 mm.

27. The production apparatus of a carbon fiber precursor fiber bundle according to claim 23, wherein the grooves are semicircular or a part of a circle, and the diameter thereof is from 2 to 10 mm, and the depth of the grooves are from 1.5 to 4 mm.

28. The production apparatus of a carbon fiber precursor fiber bundle according to claim 23, wherein the grooves are trapezoidal grooves, and the dimension of the long side of the trapezoidal groove section is from 2 to 10 mm, and the dimension of the short side corresponding to the groove bottom is from 1.5 to 6 mm.

29. A production method of a carbon fiber, characterized in that the carbon fiber precursor fiber bundle according to any of claims 1 to 4 is fed to a flame retarding step, and is fired while being divided into small tows by the tension generated in the flame retarding step.

30. A production method of a carbon fiber, characterized in that the carbon fiber precursor fiber bundle according to any of claims 1 to 4 is fed to a carbonization step, and is fired while being divided into small tows by the tension generated in the carbonization step.

31. A production method of a carbon fiber, characterized in that the carbon fiber precursor fiber bundle according to any of claims 1 to 4 is fed to a carbonization step, and is fired while being divided into small tows by the tension generated in the carbonization step.

32. A carbon fiber characterized in that the carbon fiber is produced by the method according to claim 31 and the strand strength thereof defined by JIS R7601-1986 is 420 kg/mm^2 or more.

[0068]

An intermingling device has, for example, a structure shown in Figure 4 which device includes a yarn channel having a flat rectangular sectional shape and a plurality of air jet holes disposed with a predetermined interval along the long side direction of the flat rectangular sectional shape in the yarn channel. As for the long side dimension, there is a preferable range from the viewpoint of controlling the total fineness of the small tow and the tow width. The numerical value representing such a preferable range is the value of the ratio D/L of the total fineness D (dTex) of the small tow to the long side dimension L (mm) of the flat section, and the ratio value is preferably from 2000 to 12000 dTtex/mm. In this connection, the hole size of each of the air jet holes is preferably from 0.3 to 1.2 mm, and more preferably from 0.5 to 1.0 mm.